

Background

- Vibration tables are used to verify that components will be able to withstand the vibrations they endure during operation
- Micro Motion produces flow meters of various sizes; smaller flow meters contain electronic components that need to be tested on a small vibration table
- Micro Motion desires to find resonant frequencies of these components

Design Objectives

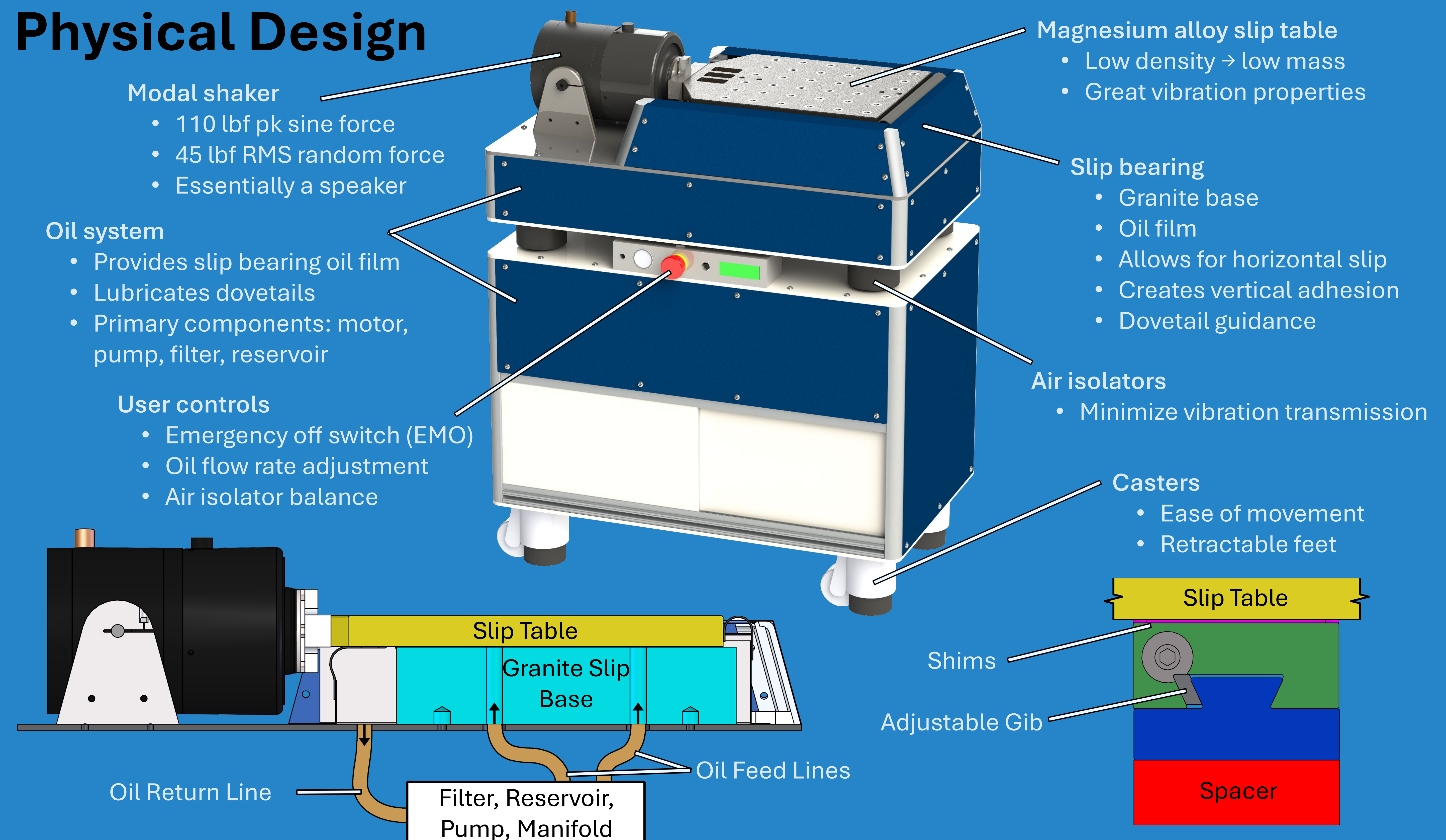
Mechanical System

- Horizontal slip table - **12 in. x 12 in.** working area
- 50 lb** payload capacity
- Threaded fixture holes
- Vibration isolation** system
- Slip bearing lifetime **>1 year**
- Removable shaker
- Maneuverable by **one person**

Control System

- Frequency range **5 - 3000 Hz**
- Sine, Sine Sweep, and Random PSD vibration
- 4x accelerometer inputs w/ BNC connections
- User friendly graphical user interface (GUI)
- Signal error **less than 5%**

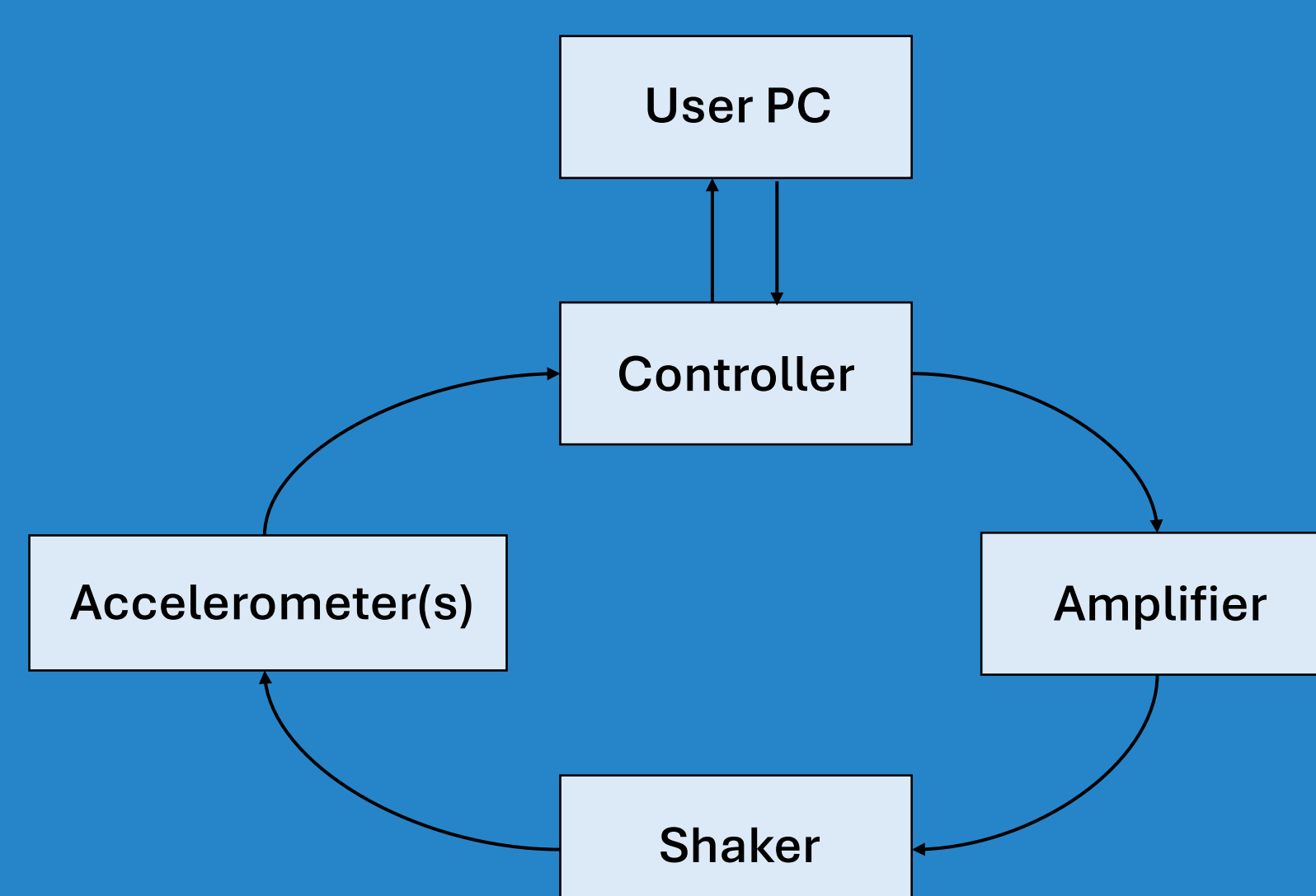
Physical Design



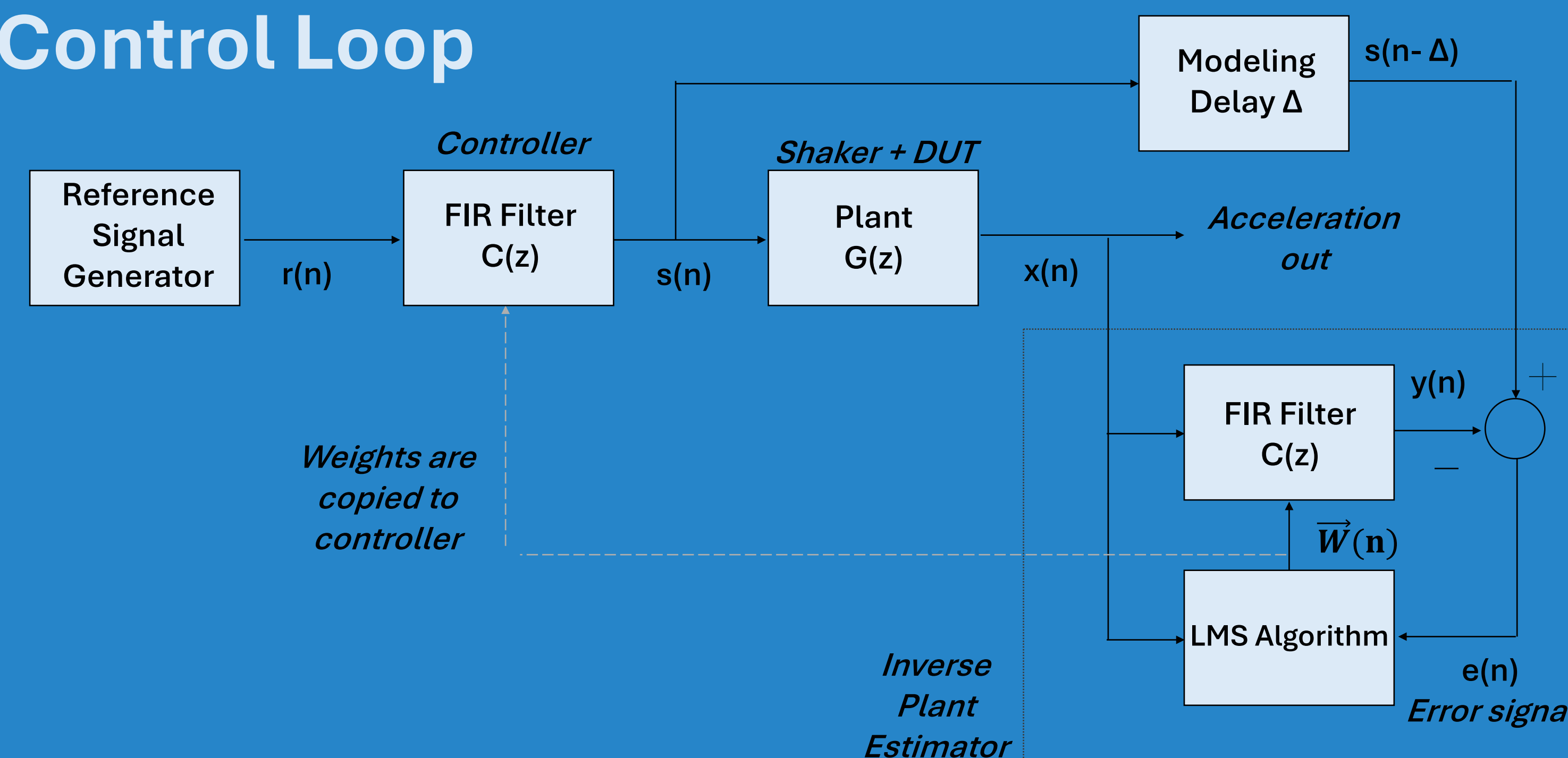
Control System

- Based on National Instruments hardware (cRIO + DAQmx) and software (LabView)
- Real-time adaptive control via Inverse Plant Estimator
- Finite Impulse Response (FIR) filter used as controller
- 51.2 kHz sampling frequency

Hardware Block Diagram



Control Loop



LMS Algorithm - Recursive Update Rule

$$\vec{w}(n + 1) = \vec{w}(n) + \mu * e(n) * \vec{x}(n)$$

Where:

- \vec{w} - the filter coefficients
- μ - the step size
- e - the error
- \vec{x} - the response signal at each sample time

Results

Testing Completed

- Verified that the Vibe Table can be moved by **one person**.
- Observed **filter eliminating debris**
- Tested system with **50 lbs.** payload
- Air Isolator reduced system vibration.
- Signal error **less than 5%**

Future Development

- Update control system for improved accuracy
- Control accelerometer averaging
- Additional vibration modes : Sine-on-Random, Shock, Etc.
- Develop part placement assistant program
- Add handles for pulling and lifting
- Build shaker cradle for easier shaker reinstallation.
- Test life cycle of bearing operation for greater than one year